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ABSTRACT

An evaluation of the laboratory science program developed in the Clover, South Carolina, Middle School produced the following results: (1) Although the general attitude toward science, according to the attitude scale, appeared to be declining in both groups, the experimental groups showed a more positive attitude toward science than did the control group; (2) The attitude toward science did not appear to differ across grades; (3) The experimental group showed higher achievement test scores than the control group; (4) It appeared that the control group was making "normal" progress; and (5) It appeared that the experimental group was making above-average gains in performance. These gains were linear and cumulative. (Author/CP)

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Science Coordinator

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PRELIMINARY

Evaluation Report

Second Budget Period

Laboratory Science Program in Clover

Project ~~Grant~~ No: SPSC 69-6814-0

Clover School District
South Carolina
June, 1971

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- Foreword -

The information on the following pages is the evaluation of the second year of a three year project designed as a demonstration program to create an awareness and a willingness to try non-conventional methods and techniques in teaching elementary science in the Clover School District. Specific goals of the project were (1) to increase science achievement among fifth, sixth and seventh grade pupils of the Clover Middle School and (2) to determine the degree to which student attitudes about science are changed as a result of teaching science concepts by the laboratory technique.

A teacher-coordinator has been employed through the project by the Clover School District who has the major responsibility for the conduct of project activities. A teacher aide has been provided for the program through the use of local funds. During the 1969-1970 school year a progr[illegible] outline was developed by teachers and science coordinator which outlines the program for teaching science concepts by laboratory techniques for students in grades four, five, and six in the Kinard Elementary School. This guide was published during July, 1970 and distributed to teachers in the district for use. During the summer 1970, a program outline was developed for seventh grade students and was utilized during the 1970-71 school year. Due to a district reorganization the program was changed from Kinard Elementary School to the Clover Middle School. Students in the 1970-71 experimental classes (5-6-7) were students who had been enrolled in the experimental classes the previous year (4-5-6). In addition a variety of materials for laboratory science study have been identified, developed and utilized.

A. Process Evaluation

The process evaluation has been conducted by the use of local district personnel, S. C. Department of Education personnel, and an out-of-state consultant.

The superintendent of the Clover School District and the principal of Clover Middle School have worked closely with the science coordinator in the implementation of the project. Classroom visitation and consultation with the coordinator have been the primary means utilized by these individuals. Herb Tyler, Field Testing Coordinator of the Region V Educational Services Center has served to assist in project implementation and to provide feedback and suggestions for project improvement. Dr. Donald Kubler , science consultant of Furman University has served in an advisory capacity to the project during the school year.

B. Product Evaluation

Objective: To increase the science achievement among 182 fifth, sixth, and seventh grade pupils enrolled in the Clover Middle School as follows:

a. Fifth grade from mean of 5.1 to mean of 6.5
b. Sixth grade from mean of 6.5 to mean of 7.5
c. Seventh grade from mean of 7.7 to mean of 8.5

as measured by the Stanford Science Achievement Test through the provision of a science program utilizing laboratory experiences in a discovery approach.

In order to determine whether or not there had been increased achievement in science during the academic year, the Stanford Science Achievement Test was administered to the six experimental classrooms and the four control classrooms as a pre-test and a post-test. The pre-test was administered on October 8, 1969; the post test was given on May 8, 1970. Equivalent Forms X and Y were used for the pre-test and post tests, respectively. Intermediate I level was used in the fourth grade, and Intermediate II in the fifth and sixth grades. In March, 1971 a post-test was administered and the post-test test from 1970 was utilized as a pre-test.

The Stanford Science Achievement Test is a valid instrument for measuring achievement in traditional curricula. It is less valid , however, for measuring achievement related to the objectives of the new science curricula; its emphasis appears to be on the recall of facts and concepts rather than on the processes of science and the functional application of concepts. The limitation of such tests for the purpose of evaluating experimental programs like the Clover Science Program has been often noted. They continue

to be used, as in this case, because appropriate standardized instruments are not yet available. It should be noted, also, that a test valid for the experimental program would suffer a lack of validity with relation to the control group science program; this is the dilemma inevitably faced when two programs with different objectives are compared. Scores on the Stanford Science Achievement Test, then, will reflect achievement in traditional objectives and offer a basis of comparison between the experimental and control groups in such achievement.

Analysis of Data

Examination of Tables #1, #2, and #3 reveal that the objective for science achievement has been met with the experimental classes. The data was analyzed using an IBM 7040 computer in conjunction with program MANOVA (Multi-Variate Analysis of Variance) from the University of Miami Biometric Laboratory statistical package.

The achievement data consist of 11 classes, 6 experimental classes, and 7 control classess--two classes in each grade (5, 6, 7) with the exception of control grade 6, which contains 3 classes.

The data lend themselves naturally to analysis by a three factor analysis of variance design of grades x treatments, with teachers (classes) nested within the cells. Examination of the class means in Table #1 shows little teacher effect within cells; however to increase generality the design was treated as though teacher effects do exist, and the appropriate residual error term was used for analysis. Thus the results of this experiment generalize beyond the particular teachers used.

Table #2 shows the combined class means, and graph #1 plots these means. It is quickly ascertained by inspection of graph #1 that there is a large difference between experimental anc control groups. It should be emphasized that these groups were not equated at the start of the year. The analysis was done on post-test scores of students who have participated two years in the program. Differences which were not apparent the first year (i.e. not statistically significant) may well be detectable this year. The only difference in the groups is the two years participation in the program, thus it is reasonable to attribute group differences to the program--but after two years of operation.

Consideration of Table #3, the ANOVA table, shows that the grades do differ in performance. This is entirely reasonable, as it is certainly not expected that the 5th graders would do as well as (for example) the 7th graders.

Further consideration of Table #3 shows that there is a significant treatment effect; thus it can be said that students in the lab program score significantly better on achievement as measured by this test.

Consideration of the interaction term in Table #3 shows no significant interaction between grade and treatment, indicating that the treatment is equally successful with all grades. While Graph #2 depicts some interaction (in that it appears that the 6th grade experimental does better than expected), it must be concluded that this is sampling error which will not exist with different groups.

It should be noted that regardless of whether or not there exists interaction, the experimental group does better than the control at all levels.

The obvious post hoc comparisons to make are with the previous year's data. Table #4 reproduces the data for last year--pre-test 70, post-test 70--along with the data for this year. Graph 3a,b,c depicts this data.

Although no trend analysis was performed, the data appear to be linear in nature. While this is to be theoretically expected, with a gain of 1.0 grade level normal, it is clear that while this is approximately true for the control group, it is certainly not true for the experimental group. It appears that the experimental group gains more than one grade level per year. Mathematically, it is said that the data are linear for both groups, but the slope of the line is greater for the experimental group than for the control group.

Two effects can be noted immediately from the graph.

1) The groups were approximately (statistically) equal at the start of the experiment.
2) Barring any ceiling effect, it is to be expected that the difference between the experimental group and control group to increase linearly each year.

It appears critical to this writer that it be determined if #2 above is true. If #2 is correct, it appears beneficial to start this program as early as practical in the schools, in order that the students reap the benefits each year. If #2 is not correct, it would seem important to determine how long the program is beneficial, in order that the students remain in the program for the most appropriate length of time before "switching" to another program.

SUMMARY:

The experimental program appears to be successful in that the students enrolled in the experimental classes scored higher on achievement than the control students.

For the length of time the program has run, it appears that the

gains made by the students are cumulative, with no "leveling" yet occuring.

The effect appears to be beneficial at all grade levels.

TABLE #1

Means by Classes, Treatment, and Grade

	Grade 5	Grade 6	Grade 7
EXPERIMENTAL			
Class 1	7.57 n=21	9.49 n=24	10.22 n=23
Class 2	6.57 n=22	8.63 n=25	8.82 n=19
CONTROL			
Class 1	5.25 n=26	5.36 n = 8	8.01 n=19
Class 2	4.78 n=15	5.10 n=15	7.42 n = 5
Class 3		7.57 n=11	

TABLE #2

Means by Treatment and Grade

	Grade 5	Grade 6	Grade 7
EXPERIMENTAL	7.06 n=43	9.05 n=49	9.58 n=42
CONTROL	5.09 n=41	5.96 n=34	7.83 n=24

TABLE #3

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F	P
Treatment	358.97	1	358.97	29.12	.001
Grade	251.07	2	125.53	10.18	.01
Treatment x Grade	20.25	2	10.13	.82	NS
Residual	86.29	7	12.33		
Total	716.57	13			

TABLE #4

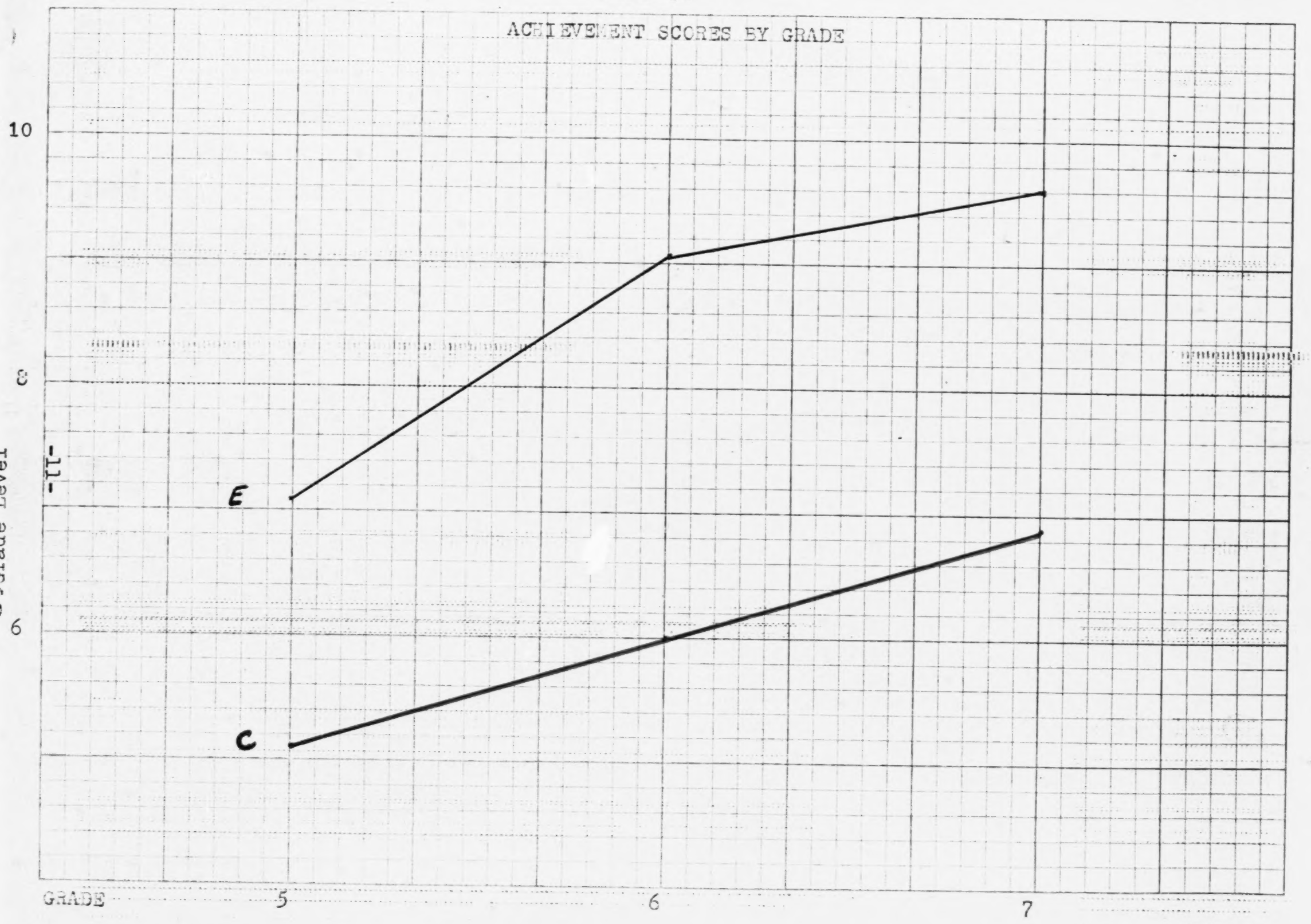
PREVIOUS ACHIEVEMENT DATA *Means*

	PRE (70) *	POST (70)	POST (71)
Experimental			
Grade 4 (5)	3.9	5.1	7.1
Grade 5 (6)	4.6	6.8	9.1
Grade 6 (7)	6.1	7.7	9.6
Control			
Grade 4 (5)	3.7	4.6	5.1
Grade 5 (6)	4.6	5.5	6.0
Grade 6 (7)	6.2	7.2	7.9

* Beginning of Program

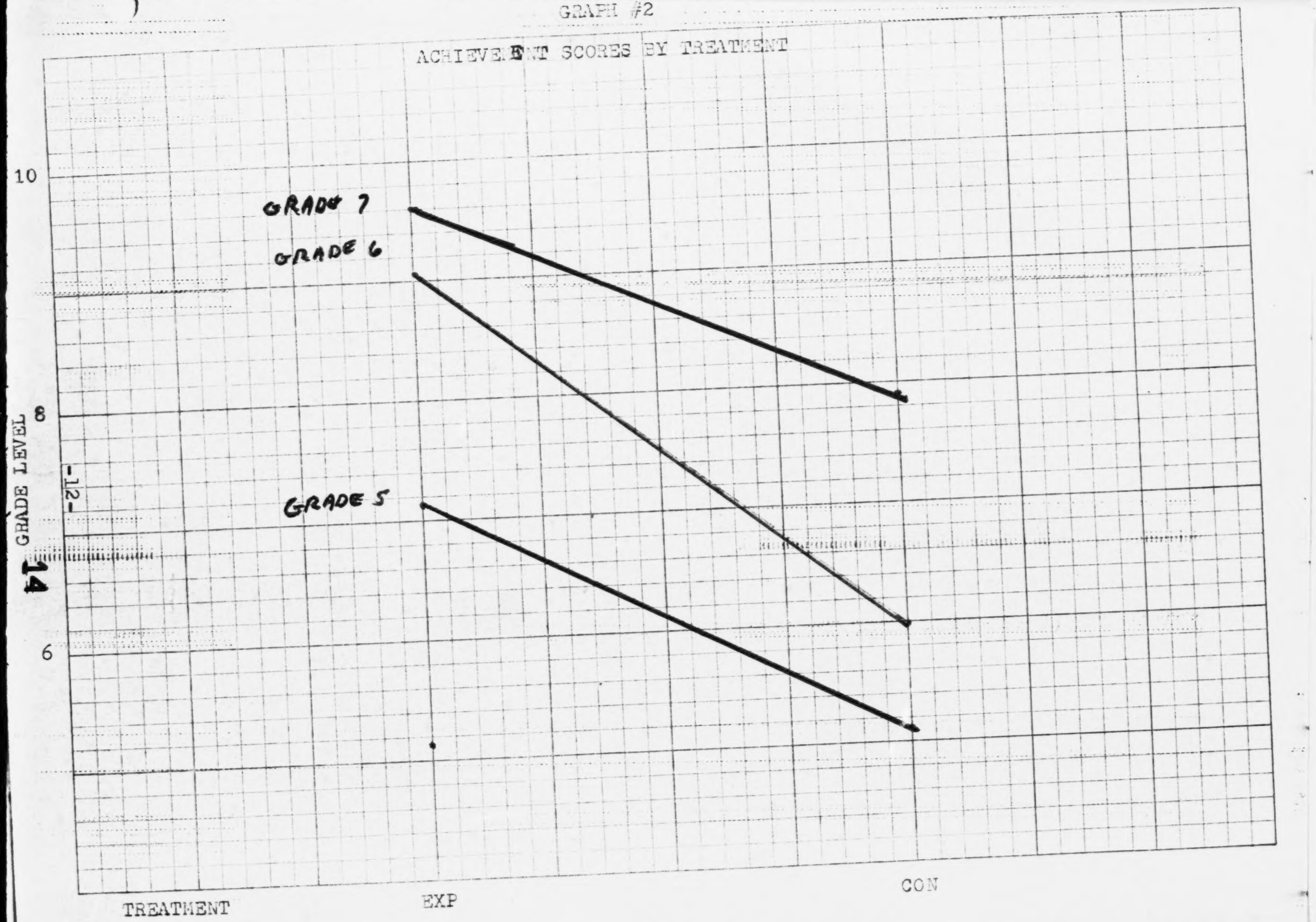
GRAPH #1

ACHIEVEMENT SCORES BY GRADE



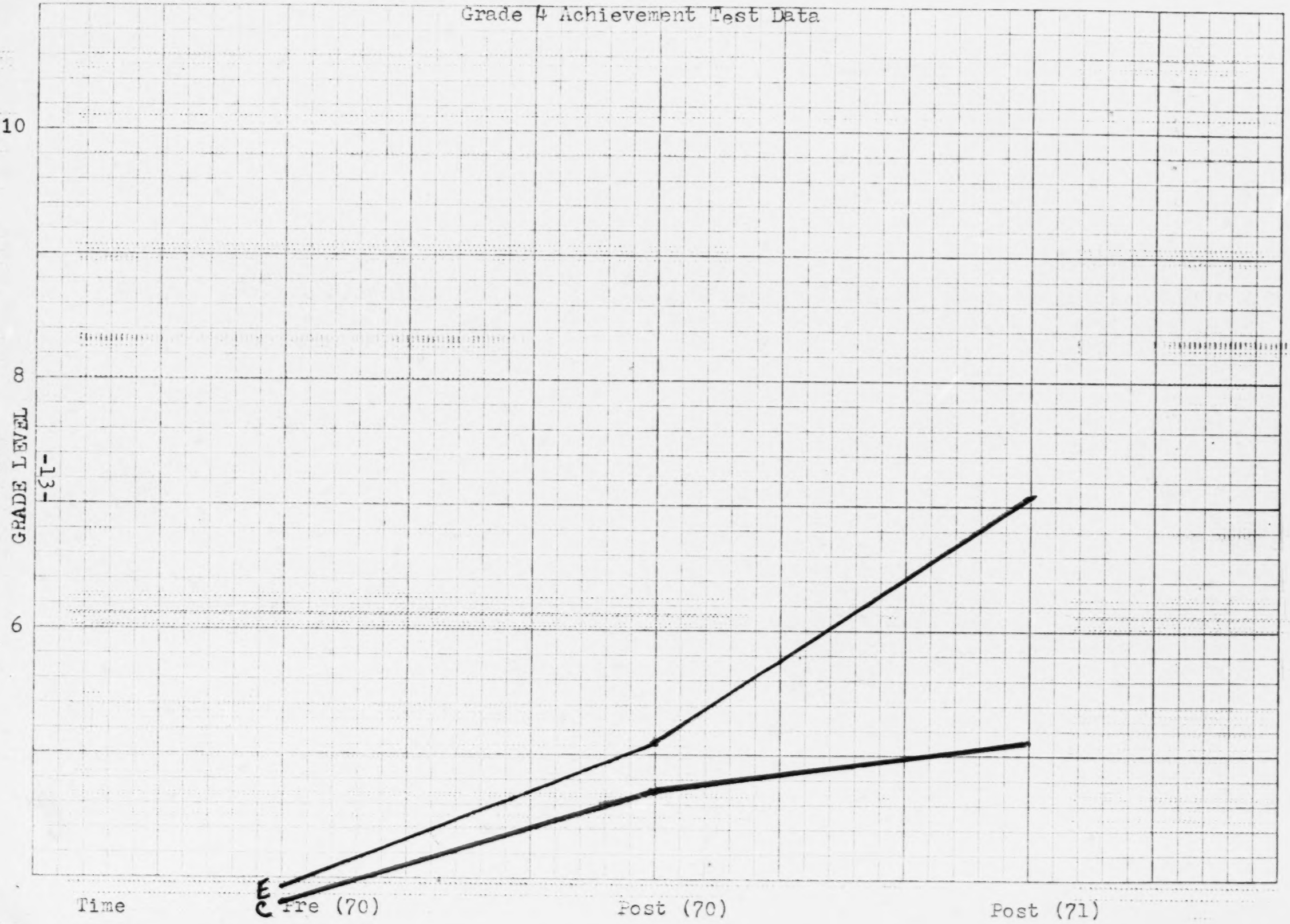
GRAPH #2

ACHIEVEMENT SCORES BY TREATMENT



Graph 3a

Grade 4 Achievement Test Data



GRAPH 3b

Grade 5 Achievement Test Data

GRAPH 3c

Grade 6 Achievement Test Data

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Objective: To determine the degree to which student and teacher attitudes about science are changed as a result of teaching science concepts by laboratory techniques.

Student Attitudes

In order to measure possible changes in student attitude toward science, the Aims-of-Science- Learning Attitude Scale was administered as a pre-test in October, 1969, and as a post-test in April, 1970 and this is an empirical scale; that is, it is composed of items which have been demonstrated to discriminate between two criterion groups--one a group of fourth, fifth, and sixth grade children identified by teachers as most exemplifying a learning attitude related to several of the basic objectives of science education, the other a group of fourth, fifth, and sixth graders identified by teachers as least exemplifying such an attitude. It is a Likert-tupe scale, composed of 28 items each of which is scored from 1-5, and containing both positive and negative items. Responses to each item are "Very much like me, something like me, Not sure, Not much like me, Not at all like me." High scores indicate a positive attitude. With the addition of a 29th item for this administration, the range of possible scores is 29-145. Number 29 is a simple obvious item, "Science is one of my favorite subjects."

The attitude data naturally lend themselves to a three factor analysis of variance, with teachers nested within treatment and groups. A simplfying assumption was made (on the basis of the previous year's data) that there were no teacher effects independent of the group effects, and the teacher factor was dropped--leaving a reduced 2 x 3 factorial analysis of variance, of treatment x grades. The cell means are shown in Table #1. The within-cell variances were homogeneous with pooled variance equal to 199.25.

The data were analyzed using the previously referred to program--MANOVA. It is clear from Table #2 that the only significant effect was treatment; i.e. the experimental group scored significantly better than

the control group. There was no significant grade effect or interaction effect between grades and treatment.

The conclusion being that students in the experimental condition score significantly better than the control group with respect to science attitude as measured by this test; and the effect is totally independent of grade.

Graph #1 plots the cell means in Table #1 by grade. While it appears that there is a "jump" in attitude in grade 7, (indicating grade effect) the effect was not sufficiently pronounced to show significance. Graph #2 plots the cell means in Table #1 by treatment. It is clearly shown that the experimental group had higher attitude scores for all groups. The apparent interaction is exaggerated by the expanded scale of the ordinate of the graph.

The obvious post hoc comparisons to make are with last year's students (actually, the same students--with each group being one year behind this present grade level). Table #3 reproduces last year's test data (pre and post) in addition to the data for this year. Recall that last year the trend was for the students to decline in average score as the year progressed, with the experimental group showing less decline than the control group, thus achieving a net "positive" effect between groups. Comparison of the data for the present year with the past year reveals that this decline in science attitude (as measured by this test) appears to be continuing, although there is no statistical evidence to support this conclusion. Graph #3a,b,c shows this trend clearly; along with the fact that the experimental group is unfailingly above the control group (i.e. has a more positive attitude toward science). It appears likely that without this program, the students' "attitude toward science" would be at the control group level--i.e. lower than it presently is.

SUMMARY:

The experimental group scored significantly better than the control group with respect to science attitude as measured by the Aims-of-Science Attitude Scale. The effect is independent of grade and grade x treatment interaction.

There appears to be a general decline in "positive attitude toward science" over time in both the experimental and control groups. This decline may indicate that there was no change indicated in the attitudes as reflected by the scale or that the scale itself lacks validity for the purpose for which it is being used.

TABLE #1

MEANS ON STUDENT ATTITUDE INVENTORY

	Grade 5	Grade 6	Grade 7	
Experimental	100.14 n = 44	100.23 n = 48	105.00 n = 43	101.72 n = 135
Control	97.63 n = 41	97.32 n = 34	98.80 n = 20	97.76 n = 95
	98.93 n = 85	99.02 n = 82	103.03 n = 63	

TABLE #2

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQ	D.F.	MEAN SQ	F	P
Treatments	950.13	1	950.13	4.78	.03
Grades	340.57	2	170.29	.86	NS
Treatments x Grades	405.87	2	202.94	1.02	NS
Error	44631.06	224	199.25		
Total	46327.63	229			

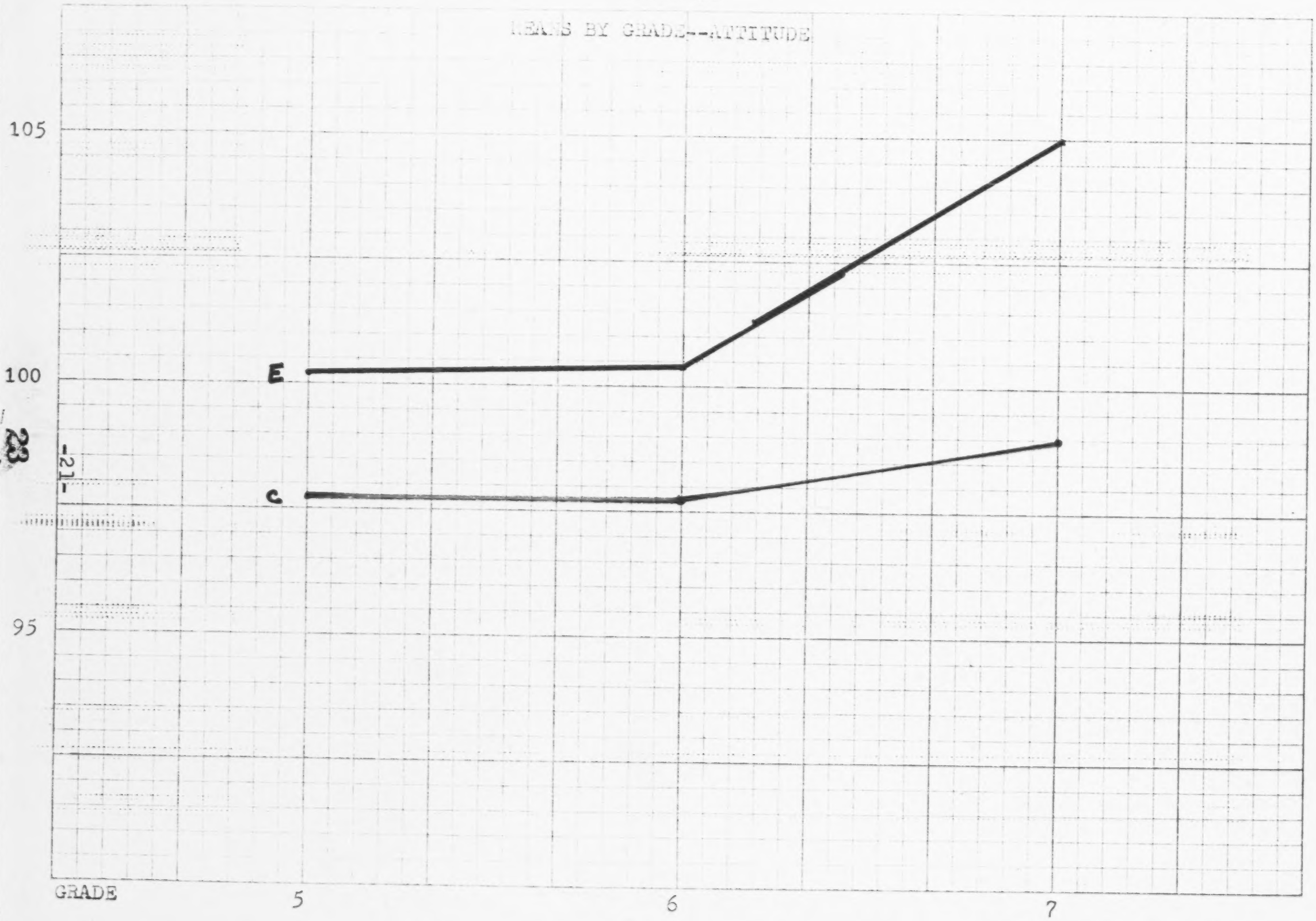
TABLE #3

PREVIOUS SCIENCE ATTITUDE DATA

	PRE (70)	POST (70)	POST (71)
Experimental			
Grade 4 (5)	104.3	102.2	100.1
Grade 5 (6)	105.2	102.5	100.2
Grade 6 (7)	102.7	102.6	105.0
Control			
Grade 4 (5)	103.2	96.2	97.6
Grade 5 (6)	100.8	99.1	97.3
Grade 6 (7)	102.0	102.5	98.8

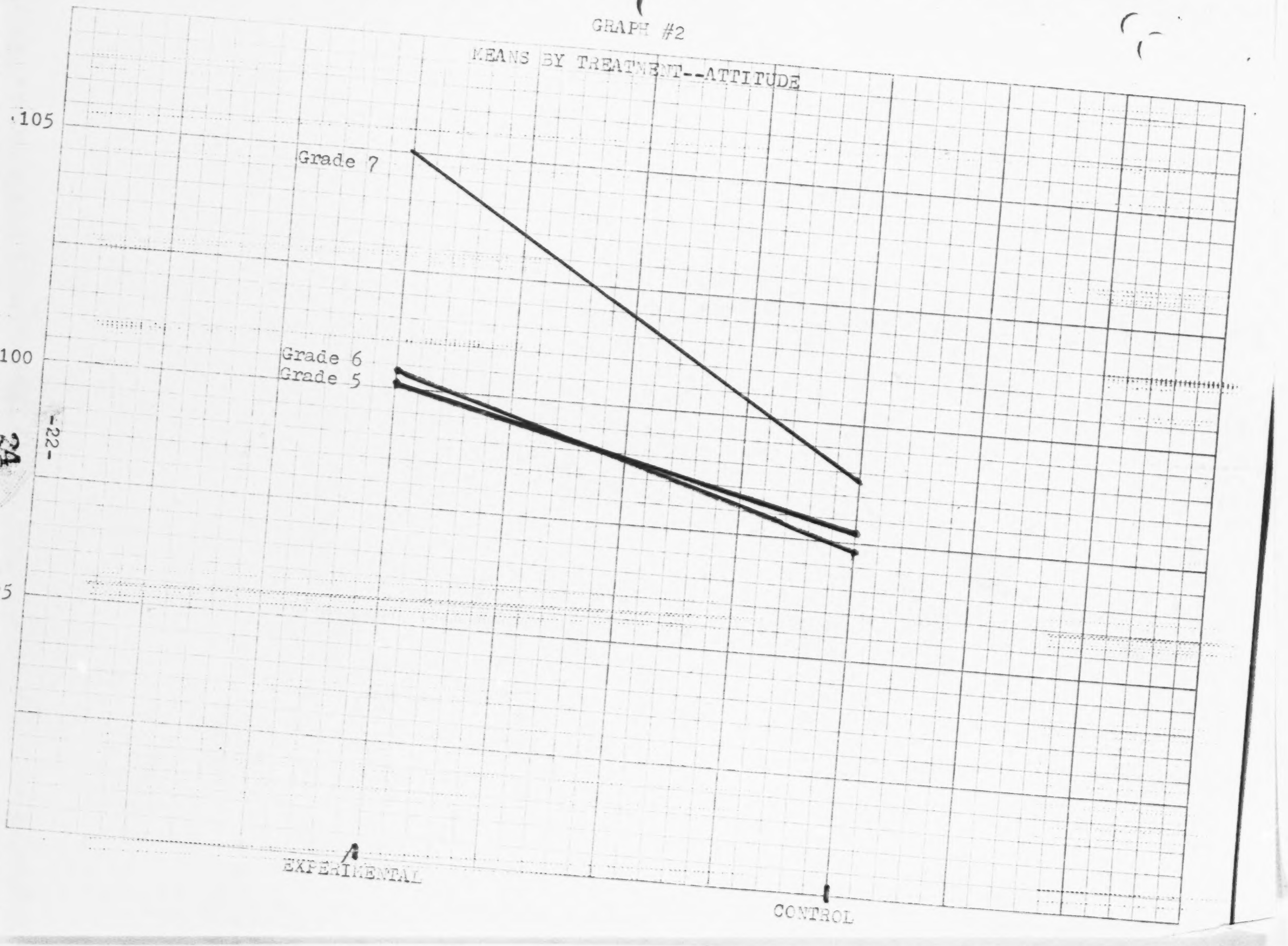
GRAPH #1

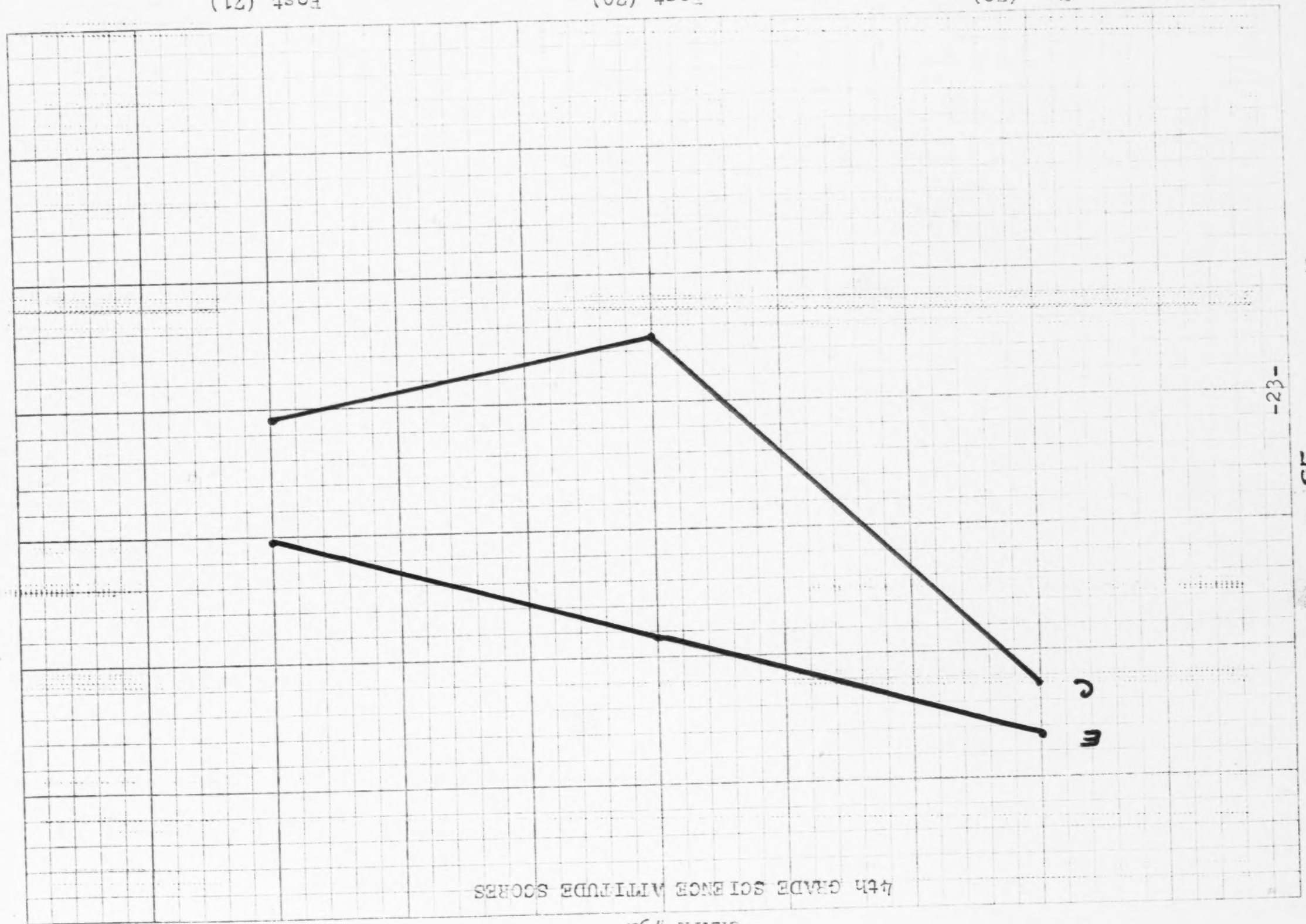
MEANS BY GRADE--ATTITUDE



GRAPH #2

MEANS BY TREATMENT--ATTITUDE

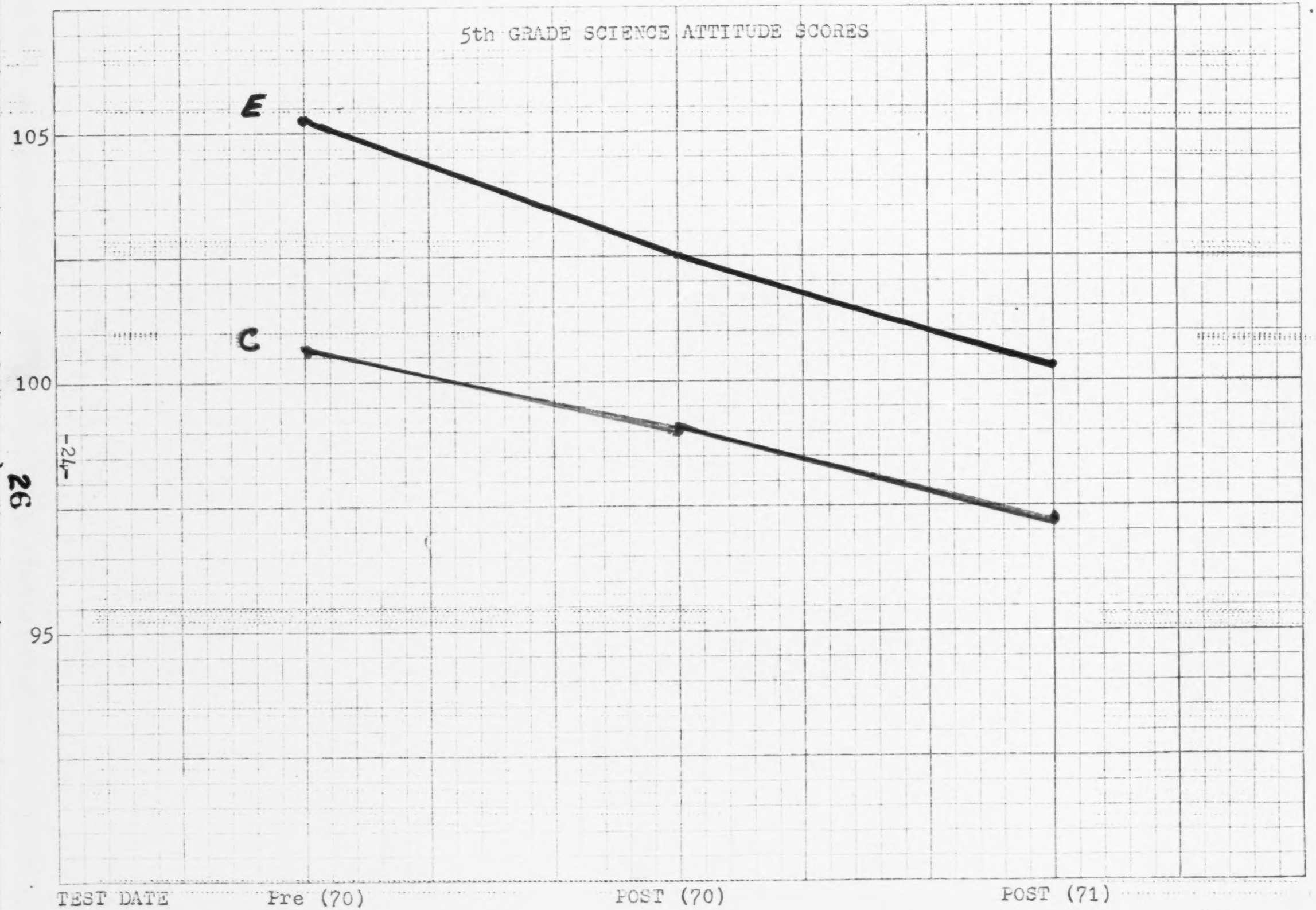




GRAPH #3a

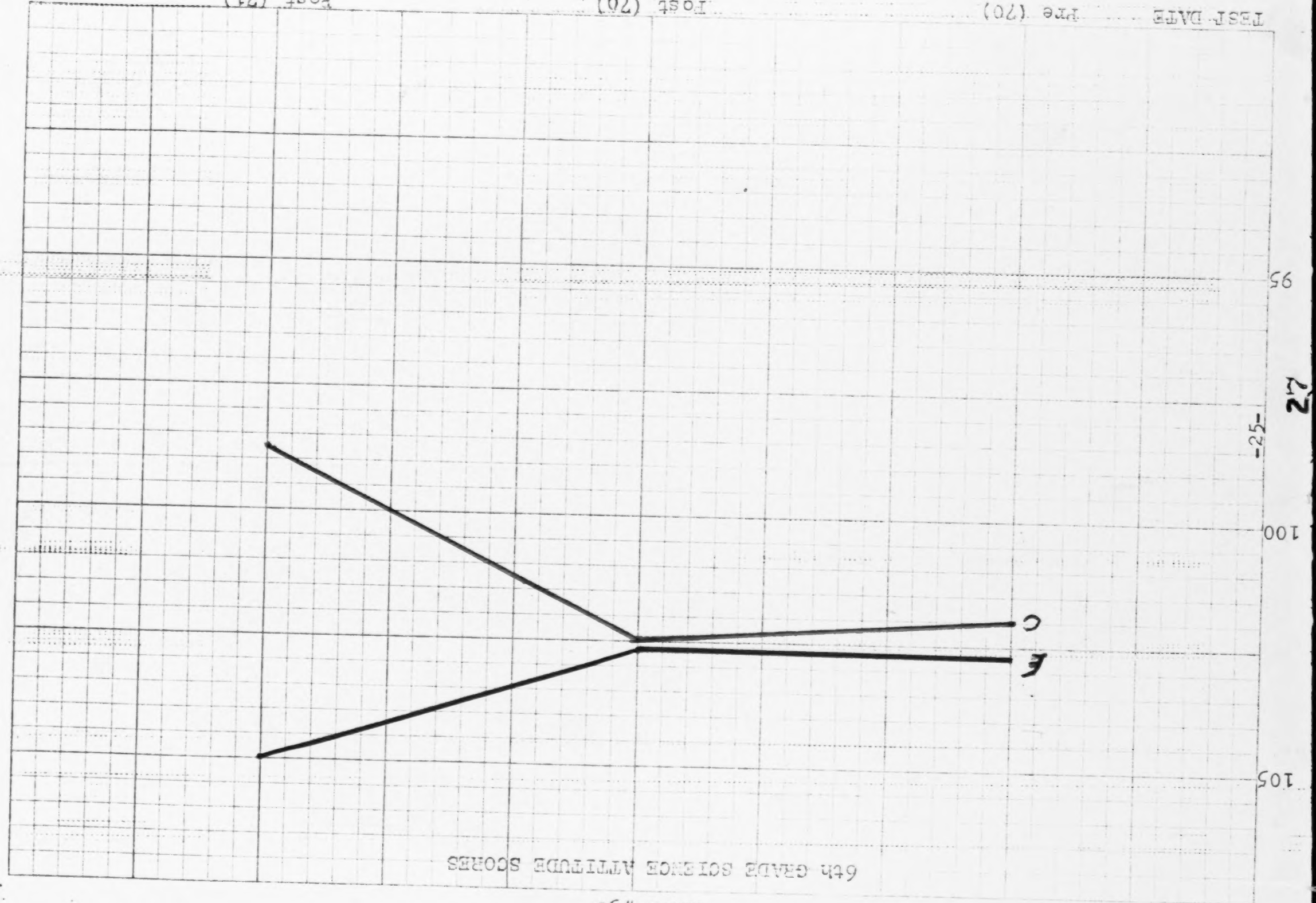
4th GRADE SCIENCE ATTITUDE SCORES

GRAPH #3b


5th GRADE SCIENCE ATTITUDE SCORES
E
C
105
100
95
TEST DATE
Pre (70)
POST (70)
POST (71)

GRAPH #3c

6th GRADE SCIENCE ATTITUDE SCORES



Teacher Attitudes

Due to the relocation of original participating teachers and reassignment of other key personnel no attempt was made to assess changes in teacher attitude.

SUMMARY

The analysis of the compiled data after two years of operation of the program showed the following results:

1) Although the general attitude toward science according to the attitude scale appears to be declining in both groups, the experimental group showed a more positive attitude toward science than the control group.

2) The attitude toward science does not appear to differ across grades.

3) The experimental group showed higher achievement test scores than the control group.

4) It appears that the control group is making "normal" progress.

5) It appears that the experimental group is making above average gains in performance; that these gains are linear and cumulative.

2. List schools and/or school districts which have adopted the objectives and activities of the project.

Visits to the project have been made by school personnel from five school districts. At least one school district (Chester County) is committed to establish two laboratory type instructional units at the fourth grade level for the 1971-72 school year. Present plans indicate that these will be gradually expanded during the coming school years as teachers become aware of the ramifications of the use of the laboratory techniques in Elementary Schools. Officials of the other four school districts have expressed an interest in development of similar programs but no firm plans have been established.

3. Summarize the influence of the project.

After one year of operation the evaluation of the influence of the project would be difficult to measure due to the fact that most of the activities of the project have been "in-house" activities designed to insure successful implementation of project activities. As dissemination activities are expanded, it is expected that the project will influence other programs and groups to a measurable extent. Classes in science education and teaching methods at Winthrop College have visited and observed the program. Teachers and administrators from six school districts have visited and observed classroom procedures and activities. Video tapesare to be made of classroom activities and will be used in teacher training at the University of South Carolina Science Education classes. Articles appearing in major news media have resulted in inquiries for information from school districts in two states. A major article is scheduled to appear in the national publication American Education. Inquiries are expected to result from this publication.